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AERIAL PHOTOINTERPRETATION OF A SMALL ICE JAM

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Aerial photos of a small ice jam on the Pemigewasett River near Plymouth, New Hampshire, were taken three days after the jam and compared with photos taken after the ice went out. The winter photos show a marked and sudden decrease in floe size apparently indicative of faster and longer movement of the ice. The spring photos show a number of shallows and obstructions that apparently had no effect on the ice movement. It is concluded that this jam was caused by a change in slope and subsequent reduction in velocity.

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Preface

This report was prepared by Stephen L. DenHartog, Geologist, Applied Research Branch, Experimental Engineering Division, U.S. Army Cold Regions Research and Engineering Laboratory.

This study was funded under the Ice Engineering Program, subprogram Ice Jam Phenomena, CWIS 31355, Field Observations of Ice Jams.

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AERIAL PHOTOINTERPRETATION OF A SMALL ICE JAM

by

Stephen L. DenHartog

INTRODUCTION

The 1975-76 winter in central New Hampshire was characterized by a long, cold January ending with a warmer than usual thaw starting on 25 January. Heavy rains during the succeeding two days led to the breakup of most of the rivers in New Hampshire and Vermont by 28 January. But since the ice was still cold and strong, the moving ice jammed in many places.

Plymouth, New Hampshire, has been flooded by backwater related to ice jams in 1927, 1936, and 1969. Minor flooding has been reported other years as well.

The Pemigewasett River ice jam near Plymouth generally occurs downstream of the town, within a 4-mile-long reach before the river goes under the U.S. Route 3 bridge. The actual jams have not been well observed because the river in this area is out of sight from Route 3 and the banks have been flooded (see Fig. 1). North Smith of CRREL, in a 20 June 1969 Trip Report, described a large gravel bar about 800 ft downstream of Spring Brook, which appeared to be the probable cause of the 1969 jam.

AERIAL PHOTOGRAPHY RESULTS

Observations on 28 January 1976 showed that no ice movement had occurred at the Route 3 bridge. However, at this time the water was high in Plymouth itself indicating a jam downstream. The river was open from about 100 yards below the highway bridge in Plymouth (Fig. 2i) upstream for an unknown distance, possibly all the way up to Lincoln, New Hampshire, about 20 miles to the north.

On 31 January and again on 30 April vertical aerial photographs were taken. The imagery clearly shows that shallow bars, bends and constrictions were not the cause of this jam. Inspection of the April photography alone or summer field observations would all point to the shallows and outcrops as the causative factors. The value of comparative photo interpretation is clearly shown.

These photos, taken using a Hasselblad camera with a 100-mm lens, are essentially reconnaissance-quality and not mapping-quality pictures. The camera is mounted in a blister added to the right door of the aircraft so any bank of the aircraft induced by a turn or turbulence will result in slightly oblique photographs and thereby scale variation across the picture.

If measurements are necessary, scale can be determined from known distances in the photos such as auto lengths and road widths, and interpolations may be made to within a few percent. These photos cover the upper half of the reach in question, and display several features which may be of interest to photo interpreters. Ten overlapping photographs (numbers 116-1976 through 126-1976), herein called Figures 2 a-j, respectively, were taken from 5500 ft above sea level on 31 January during a single pass going upstream.

Figure 2a shows a reach of the river below the jam. High water had lifted the ice but the ice had not moved very far downstream. This is evidenced by the large size of the ice pans (1) and the fact that some of the larger pieces are still fixed to the bank (2). The inked dashed lines indicate the shoreline of 30 April when water level was low, probably close to midwinter level. It is interesting to note on Figure 2a and 3a that the large rock outcrop shown by the bump on the east (lower) bank had little apparent effect on the ice movement. The left (downstream) side of Figure 2b shows the same characteristics as Figure 2a but the right side of the photo has a different character shown in the finer texture of the ice blocks. The largest blocks were generally no more than 10% of the width of the river. The matrix is seen to be much darker in tone as a result of its greater relief, which can be readily seen in stereo. The ice in this reach had moved some distance as evidenced by the shear line (3) along the west bank that is seen in both Figures 2b and 2c. but since some large ice pans were still present in this reach, the ice could not have moved very fast and probably not very far.

The right hand (upstream) portion of Figure 2c shows a third character. The entire river surface was covered with smaller pieces of broken ice having the same character and texture as the matrix in the reach downstream. Few of the pieces here were over 2 ft in their longest apparent dimension. A well-developed shear wall (4) was present on the east bank. On the surface of the shelf of shore ice (5) were larger pieces of ice that were broken loose with the initial rise in water level but which were stranded and not incorporated into the ice run. Spring Brook (6) joins the Pemigewasett from the east just upstream of the bend in the lower side of the photo. The gravel bar described by Smith in 1969 barely showed in the April photography (Fig. 3b) and does not seem to have affected this jam. The gradual transition of the texture and form of the ice cover as it is traced upstream indicates that this jam was caused by a change in surface slope and subsequent reduction in velocity.

Figures 2d-2g are included merely to show the length of the jam. They all show the typical rough surface of an ice jam, some shear lines near shore and towards the upstream end, and the inclusion of a few larger pans.

Figure 2h shows the upstream end of the jam and no indication of the bars and shallows that are so prominent on the 30 April photos. When observed from the bridge three days before the winter photos were taken (Fig. 3a, b and c), the upstream edge of the ice was nearly at the ridge edge of Figure 2h. Close inspection of this photo and also Figures 2i and 2j shows a number of arcuate ridges (7), concave upstream from the earlier edge of ice upstream to the bridge. Apparently these were formed by the loose, sporadic flow of ice which drifted downstream after the main ice run. By 31 January the weather had cooled and the flow had decreased so underturning of ice blocks and compression of the jams by internal packing was no longer happening.

The pattern in Figures 2h and 2i and the downstream portion of Figure 2j shows this gradual upstream accumulation of ice. The texture is much smoother than that shown of the major part of the jam. The open water areas, though limited, indicate an ice thickness of essentially one layer. Figure 2j shows the confluence of the Baker River (8) with the Pemigewasett (9). The ice in the Baker had not moved, which apparently decreased the severity of this jam. The ice cover on the Pemigewasett from the confluence with the Baker upstream until nearly the edge of the photograph was new ice that had frozen in place since 28 January.

By 30 April all the ice was gone, the water level was fairly low, and the leaves were not yet out. The 30 April photos show the river banks and bars at a level similar to winter conditions. A dashed line on the winter photos depicts the 30 April water line. The sand bars, bends in the channel and constrictions did not cause this jam. How much they contributed to the final location of the foot of the jam by slowing the ice movement is unknown. This jam was caused by the back water from a dam some eight miles downstream.

CONCLUSION

It is hoped that many more jams can be photographed in this fashion, and particularly that a few jams can be photographed while they are moving. These data will be quite valuable for choosing and confirming modeling techniques for site specific studies. Then these modeling techniques can be used in turn to determine economically the river modifications that will preclude jamming.

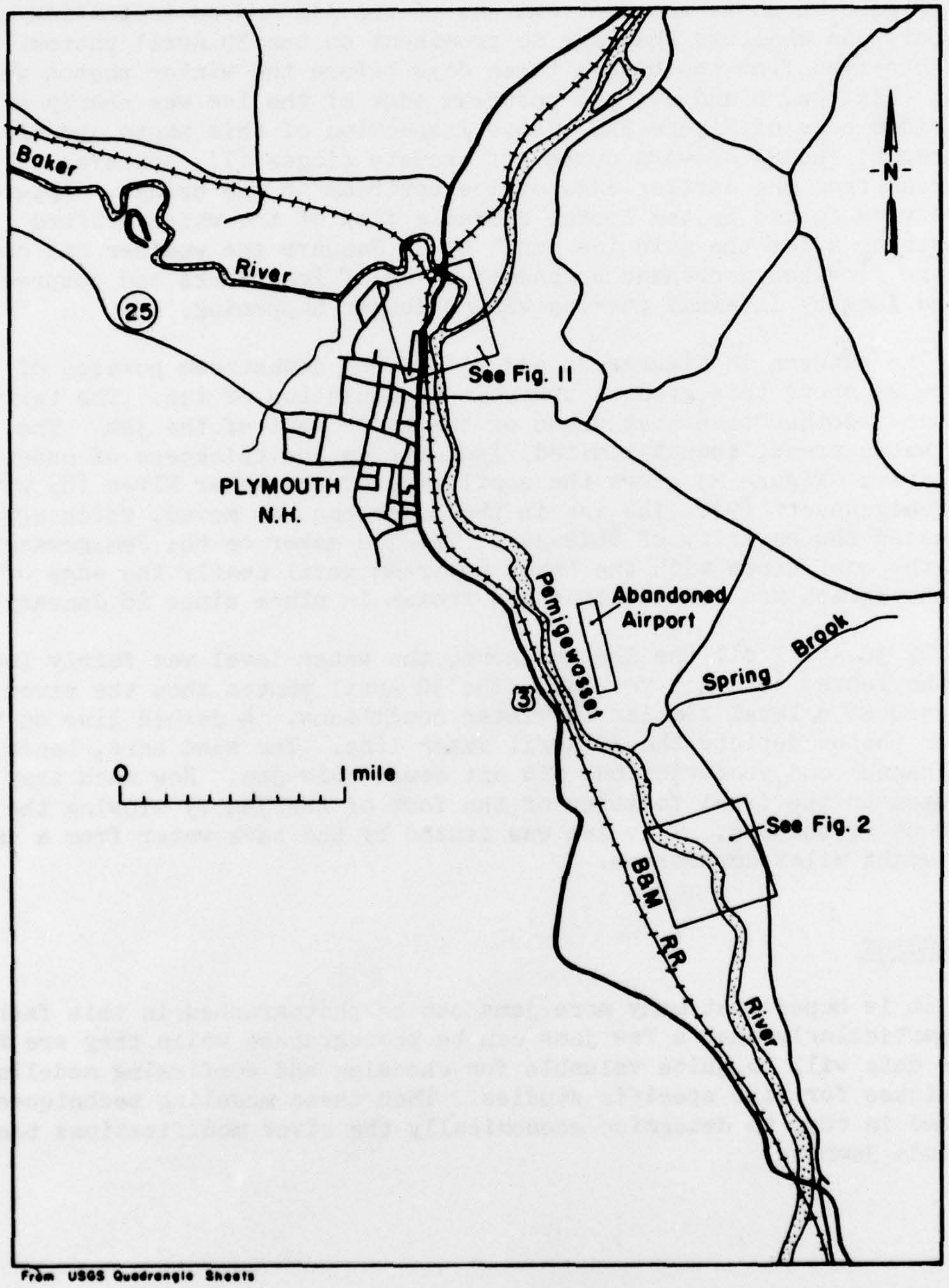
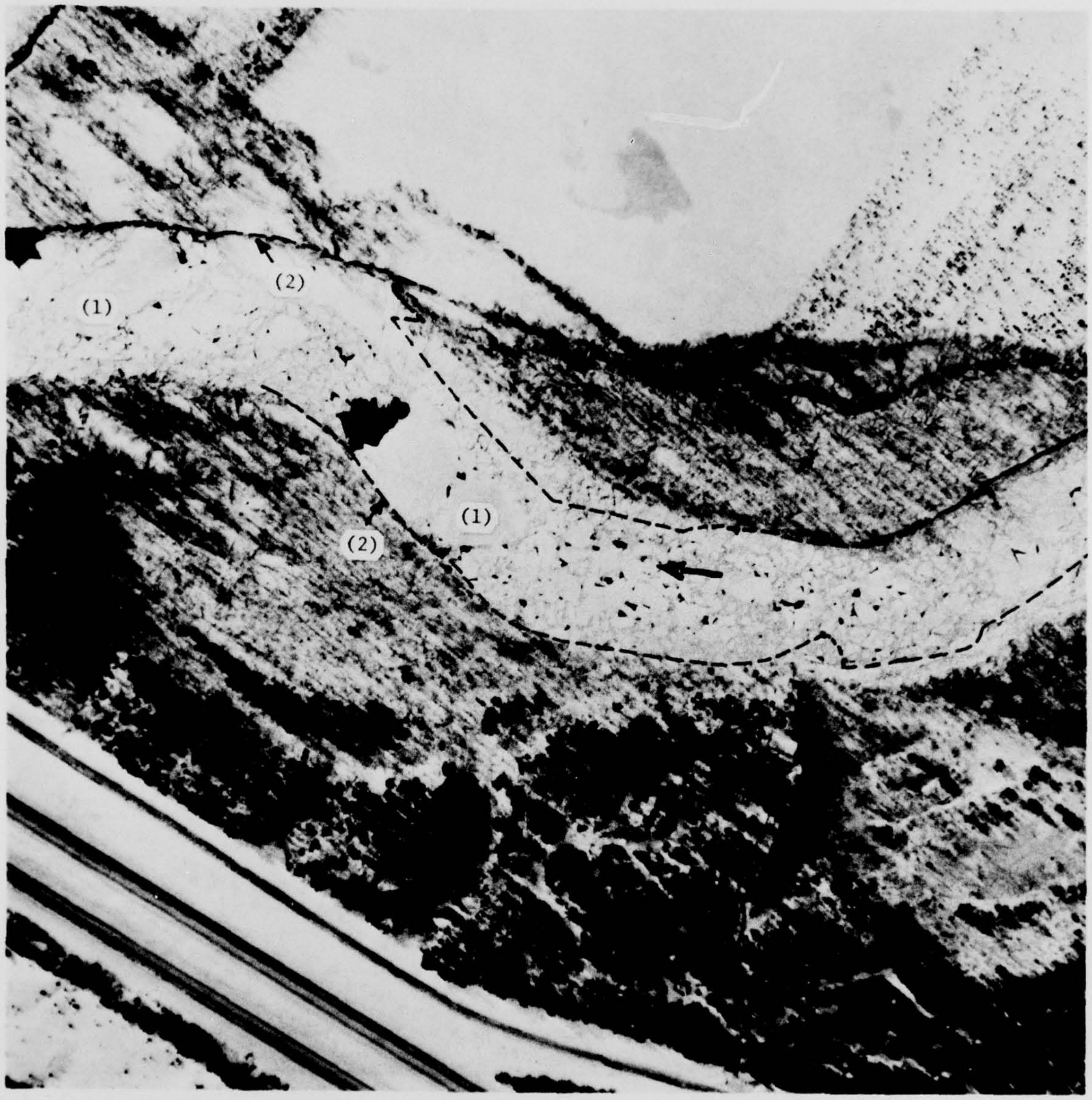


Figure 1. Pemigewasett River near Plymouth, N.H.



a

Figure 2. Aerial photograph of Pemigewasett River, during single pass, near Plymouth, N.H., 31 January 1976.

b

Figure 2 (cont'd)

c

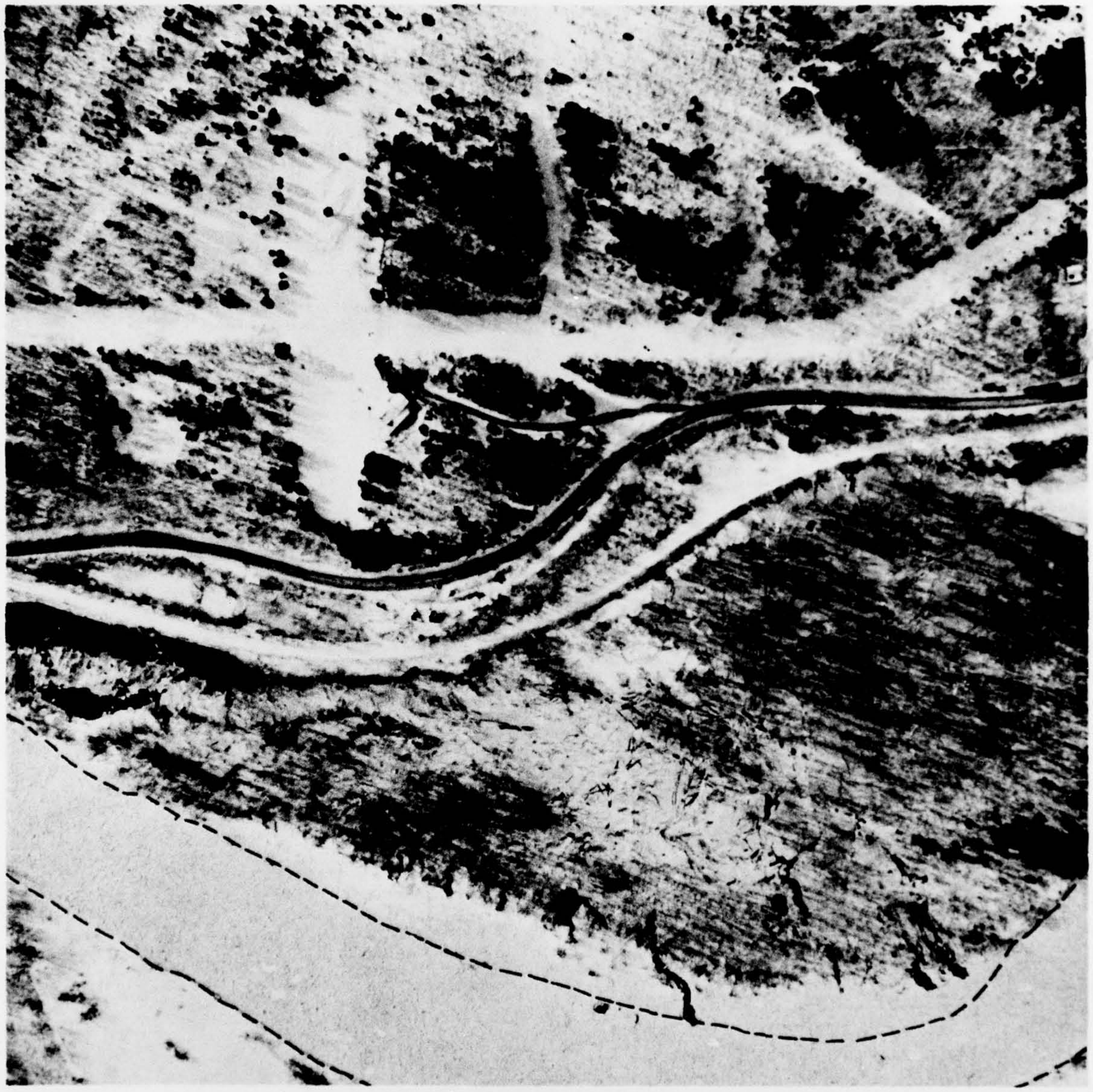
Figure 2 (cont'd)

d

Figure 2 (cont'd)

e

Figure 2 (cont'd)



f

Figure 2 (cont'd)

g

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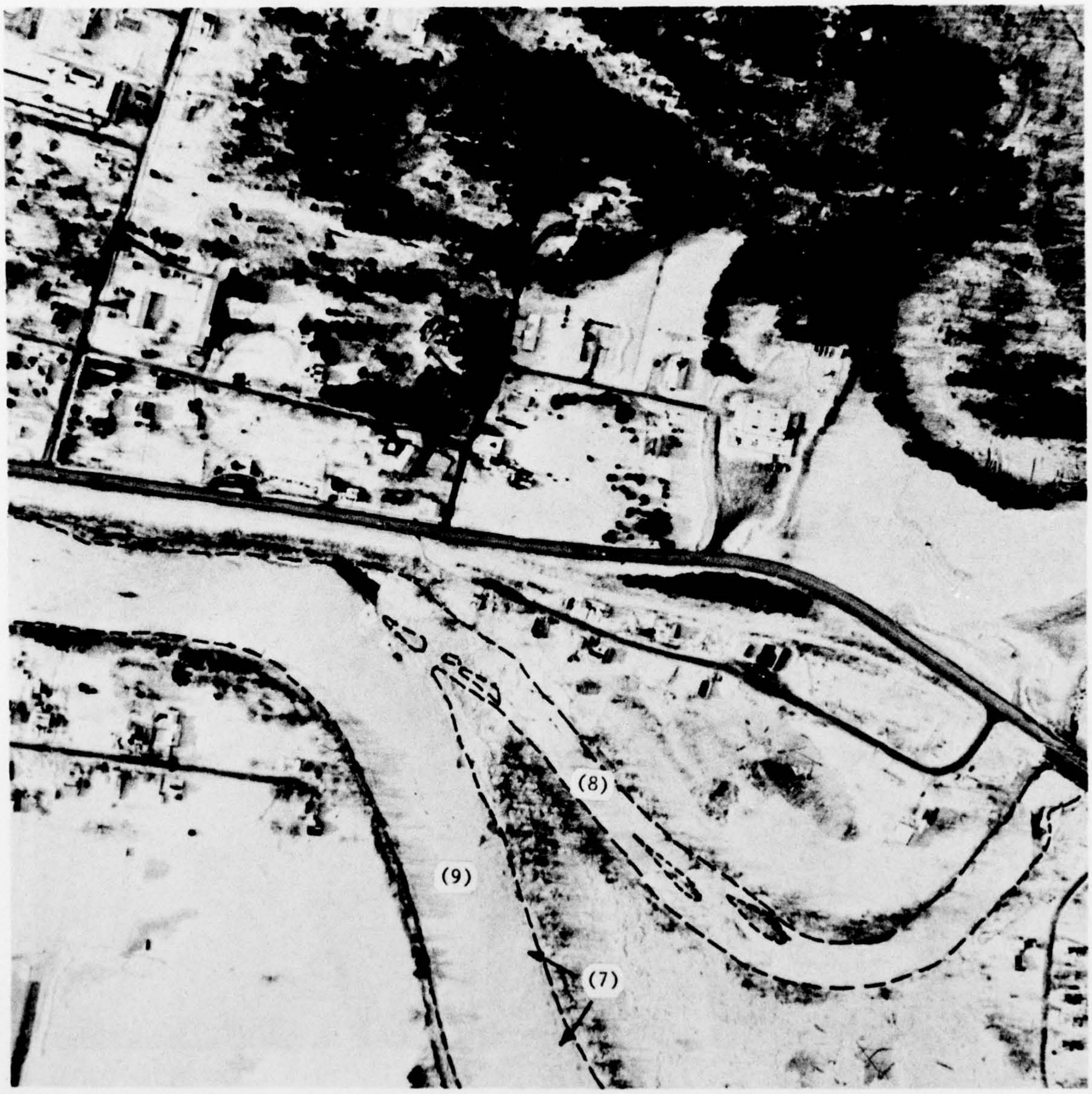
h

Figure 2 (cont'd)

i

Figure 2 (cont'd)



j

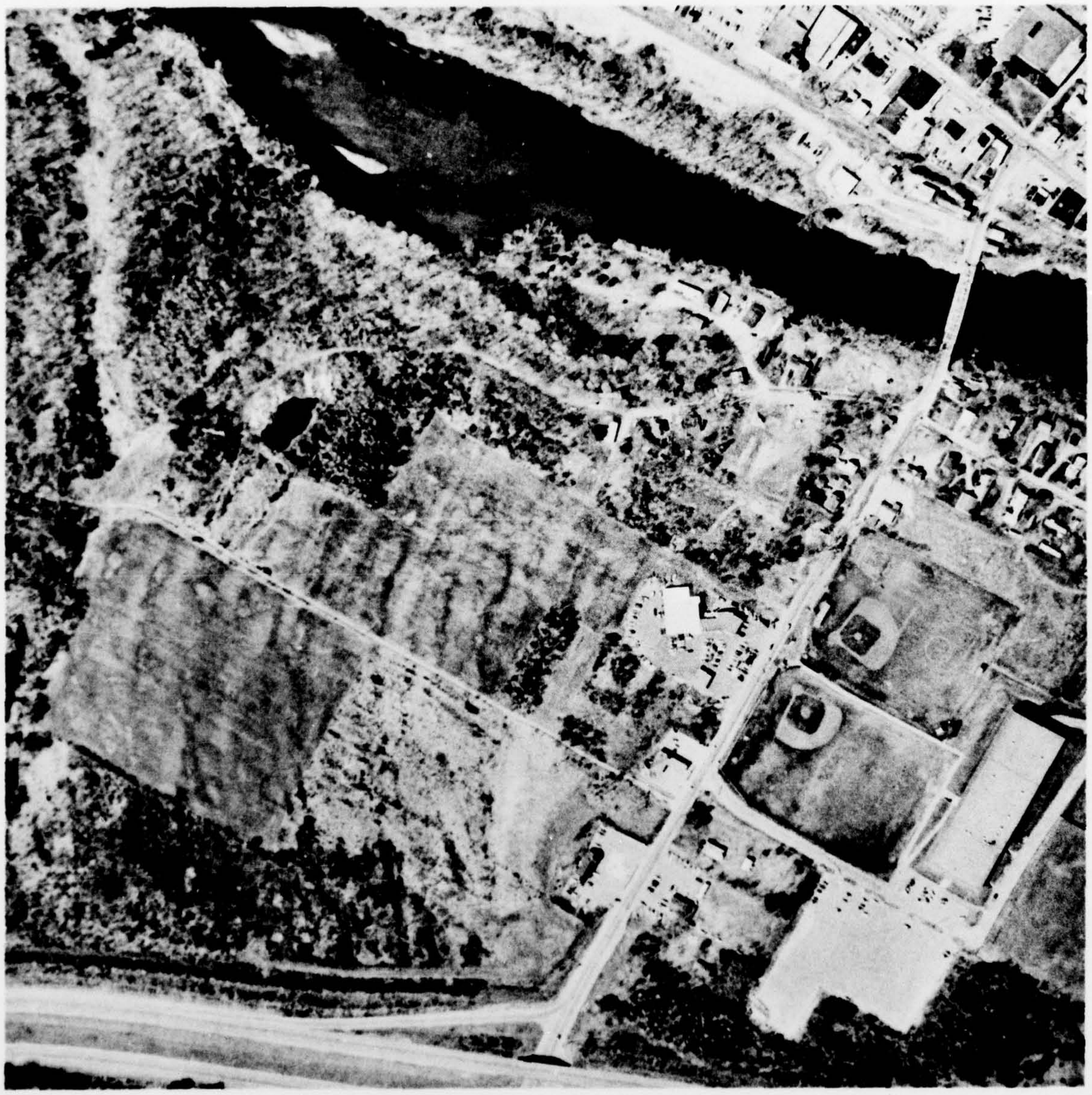
Figure 2 (cont'd)

a

Figure 3. Aerial photographs of Pemigewasett River, 30 April 1977.

b

Figure 3 (cont'd)



c

Figure 3 (cont'd)